10 A beam of electrons in a television tube moves horizontally with a velocity of 1.00 x 10^7 m/s. How far will the electrons drop as they travel a horizontal distance of 20.0 cm?

11 Standing on a balcony, you throw your keys to a friend standing on the ground below. One second after you release the keys, they have an instantaneous velocity of 13.9 m/s, directed 45^o below the horizontal. What initial velocity did you give them?

12 A baseball pitcher throws a pitch with an initial velocity of 44.0 m/s, directed horizontally. How far does the ball drop vertically by the time it crosses the plate 18.0 m away?

19 A football is kicked 60.0 meters. If the ball is in the air 5.00 s, with what initial velocity was it kicked?

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(a) How long does it take the rock to reach the ground?
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23 A passenger of mass 50.0 kg is in a car rounding a level curve of radius 100.0 m at a speed of 20.0 m/s.
(a) Assuming that static friction is the horizontal force acting on the passenger (between her and the seat), find the magnitude of that frictional force.
(b) What would happen if μ_s is 0.3?

28 As a 400 kg car rounds the top of a hill at a speed of 20.0 m/s, it very briefly loses contact with the pavement. This section of the road has an approximately circular shape
A) Find the radius *r*.
B) What would be the apparent weight of this person if they were going half as fast?

48 A certain roller coaster design uses a vertical loop of radius 8.00 m.
a) Assuming that the roller coaster remains on the track, what is the minimum speed of a car at the top of the loop?
b) What would be the apparent weight of a 55 kg person at the top of the loop if they are going twice the minimum speed?

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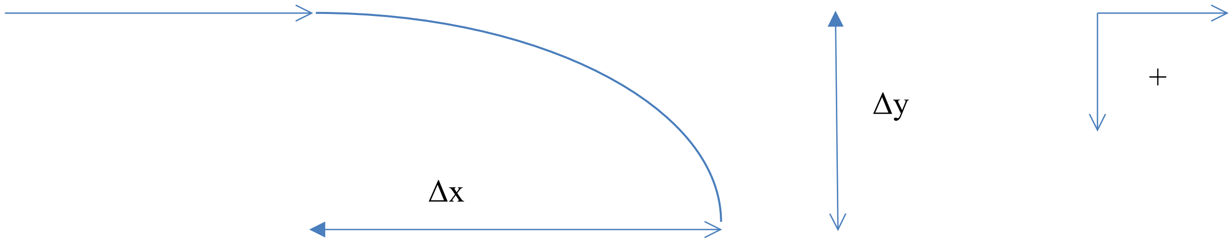


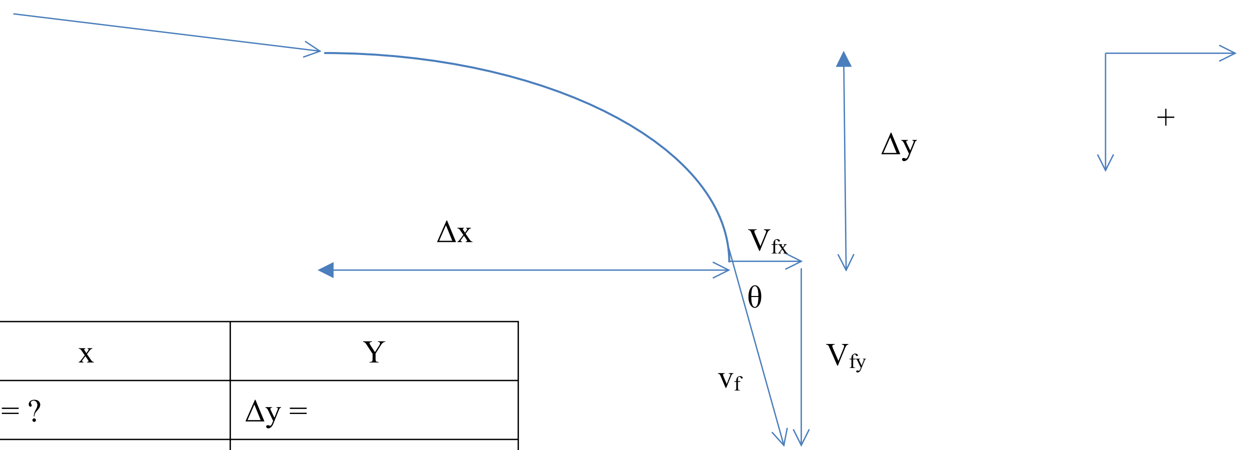
x	Y
$\Delta x = 0.20$	$\Delta y =$
$V_{ix} = 1x10^7$ m/s	$V_{iy} = 0$
$V_{fx} = 1 \text{ x } 10^7$ m/s	$V_{fy} =$
$a_x = 0$	$a_y = +\ 9.8$ m/s^2
$t_t =$	

Find Time with the x equation (more knowns there)

$$\Delta x = v_{ix}t + \tfrac{1}{2}a_x t^2$$
$$0.2\ m = (\frac{1x10^7 m}{s})\ t + 0$$
$$t = 2.0 \text{ x } 10^{-8} \text{ s}$$

$$\Delta y = v_{iy}t + \frac{1}{2}a_y t^2$$
$$\Delta y = 0 + \frac{1}{2}\left(9.8\,\frac{m}{s^2}\right)(2.0\,x\,10^{-8}s)^2$$
$$\Delta y = 2\,x\,10^{-15}m$$

11 Standing on a balcony, you throw your keys to a friend standing on the ground below. One second after you release the keys, they have an instantaneous velocity of 20 m/s, directed 45° below the horizontal. What initial velocity did you give them? (Note, we do not know if thrown horizontally or at an angle)



x	Y
Δx = ?	Δy =
V_{ix} = ?	V_{iy} =
V_{fx} = ?	V_{fy} =
$a_x = 0$	$a_y = +9.8\ m/s^2$
$t_t = 1$ s $\left\|v_f\right\| = 20\frac{m}{s}$ @ 45 *degrees below*	

First find the components of v_f

$V_{fx} = v_f \cos\theta$ $V_{fy} = v_f \sin\theta$

$V_{fx} = 20$ m/s cos 45 $V_{fy} = 20$ m/s sin 45

$V_{fx} = 14.1$ m/s $v_{fy} = 14.1$ m/s

We know that $v_{ix} = v_{fx} = 14.1$ m/s because $a_x = 0$.

Find V_{iy}

$V_{fy} = v_{iy} + a_y t_t$

14.1 m/s = v_{iy} + (9.8 m/s²)(1s)

$V_{iy} = 4.34$ m/s

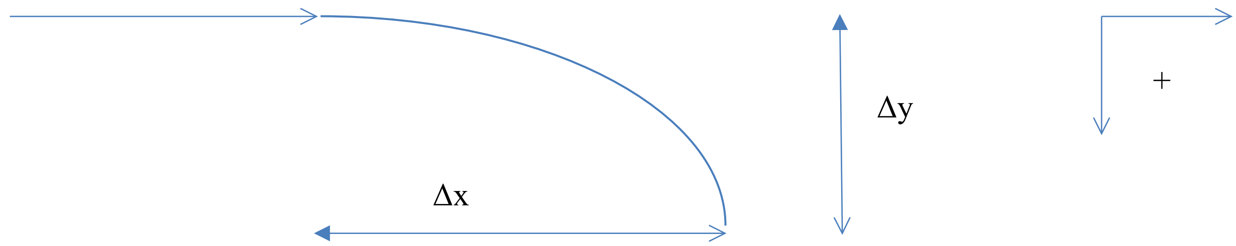
So this thing was thrown down (v_{iy} is +) and to the right (v_{ix} is +)

Find initial speed and angle

$$\left|v_i\right| = \sqrt{(v_{ix})^2 + (v_{iy})^2} \qquad \theta_i = tan^{-1}\frac{v_{iy}}{v_{ix}}$$

$$\left|v_i\right| = +/-\sqrt{(14.1\ m/s)^2 + (4.34\ m/s)^2} = 14.8 \text{ m/s} \qquad \theta_i = tan^{-1}\frac{4.34\ m/s}{14.1\ m/s} = 17.1$$

12 A baseball pitcher throws a pitch with an initial velocity of 44.0 m/s, directed horizontally. How far does the ball drop vertically by the time it crosses the plate 18.0 m away?



x	Y
$\Delta x = 18$ m	$\Delta y =$
$V_{ix} = 44$ m/s	$V_{iy} = 0$
$V_{fx} = 44$ m/s	$V_{fy} =$
$a_x = 0$	$a_y = +9.8$ m/s^2
$t_t =$	

$$\Delta x = v_{ix}t + \frac{1}{2}a_x t^2$$

$$18\ m = 44\tfrac{m}{s}t + 0$$

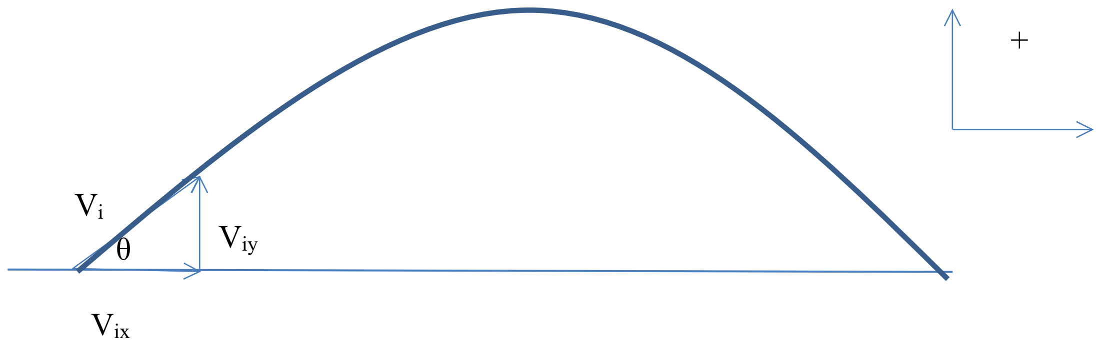
t = 0.41 s

$$\Delta y = v_{iy}t + \frac{1}{2}a_y t^2$$

$$\Delta y = 0 + \frac{1}{2}\left(9.8\,\frac{m}{s^2}\right)(0.41\ s)^2$$

$$\Delta y = 0.82\ m$$

19 A football is kicked 60.0 meters. If the ball is in the air 5.00 s, with what initial velocity was it kicked?



x	Y
$\Delta x = 60$ m	$\Delta y_t = 0$
$V_{ix} =$	$V_{iy} =$
$V_{fx} =$	$V_{fy} =$
$a_x = 0$	$a_y = -9.8$ m/s^2
$t_t = 5$ s	

$\Delta x = v_{ix}t + \frac{1}{2}a_x t^2$
$60\ m = v_{ix}(5\ s) + 0$
$V_{ix} = 12$ m/s

$\Delta y = v_{iy}t + \frac{1}{2}a_y t^2$
$0 = v_{iy}(5\ s) + \frac{1}{2}(-9.8\frac{m}{s^2})(5\ s)^2$
$V_{iy} = 24.5$ m/s

Find initial speed and angle

$|v_i| = \sqrt{(v_{ix})^2 + (v_{iy})^2}$ $\theta_i = tan^{-1}\frac{v_{iy}}{v_{ix}}$
$|v_i| = +/-\sqrt{(12\ m/s)^2 + (24.5\ m/s)^2} = 27.3$ m/s $\theta_i = tan^{-1}\frac{12\ m/s}{24.5\ m/s} = 26.1$

22 A large merry-go-round completes one revolution every 10.0 s. Compute the acceleration of a child seated on it, a distance of 6.00 m from its center.

T = 10 s
r = 6 m

First calculate the average speed

$$sp\bar{e}ed = \frac{2\pi r}{T}$$

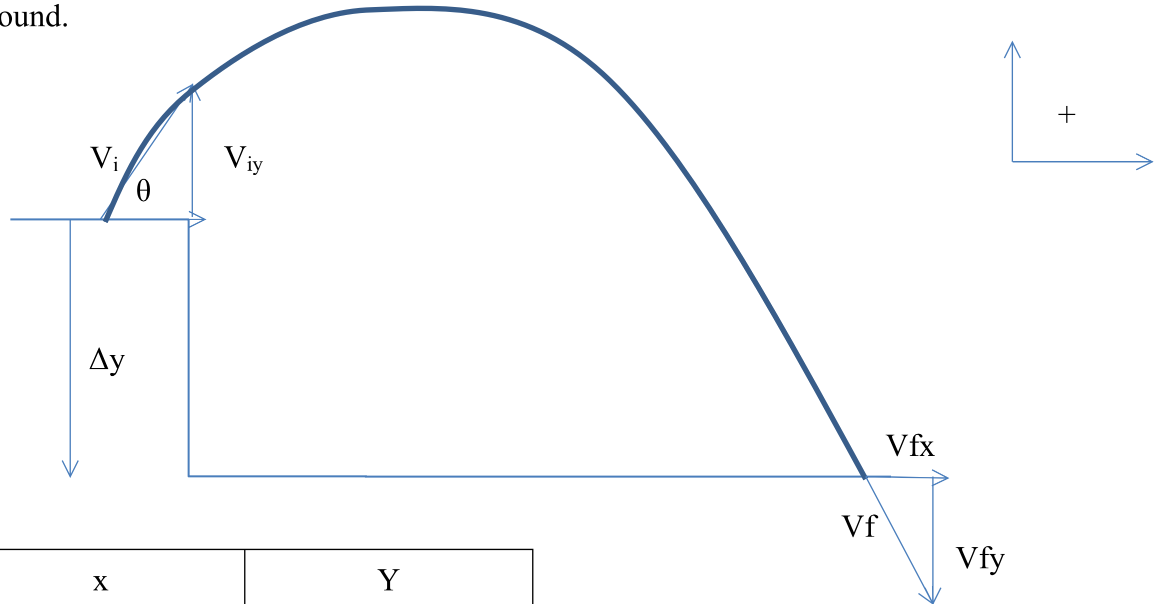
$$sp\bar{e}ed = \frac{2\pi 6\ m}{10\ s} = 3.77\ m\ /\ s$$

Find the acceleration

$$a_c = \frac{v^2}{r}$$

$$a_c = \frac{(3.77\frac{m}{s})^2}{6\ m} = 2.37\ \frac{m}{s^2}$$

50 A rock is thrown from the edge of a cliff to the ground 20.0 m below. The rock has an initial velocity of 15.0m/s, directed 30.0° above the horizontal.
(a) How long does it take the rock to reach the ground?
(b) How far from the base of the cliff does the rock strike the ground?
(c) Find the velocity of the rock just before it strikes the ground.



x	Y
$\Delta x =$	$\Delta y_t = -20.0$ m
$V_{ix} = +13.0$ m/s	$V_{iy} = +7.5$ m/s
$V_{fx} = +13.0$ m/s	$V_{fy} =$
$a_x = 0$	$a_y = -9.8$ m/s^2
$t_t =$	

First find the components of v_f

$Vi_x = v_f \cos\theta$ | $Vi_y = v_f \sin\theta$
$V_{ix} = 15$ m/s cos 30 | $V_{iy} = 15$ m/s sin 30
$V_{ix} = 13.0$ m/s | $v_{iy} = 7.5$ m/s

A) $\Delta y = v_{iy}t + \frac{1}{2}a_y t^2$

-20 m = (+7.5 m/s) t + ½ (-9.8 m/s^2)t^2

0 = -4.9t^2 +7.5t +20

$$t = \frac{-7.5 \pm \sqrt{7.5^2 - 4(-4.9)(+20)}}{2(-4.9)} = \frac{-7.5 \pm 21.2}{-9.8} = 2.93\,s \vee -1.40\,s$$

b) $\Delta x = (13.0\frac{m}{s})(2.93\,s) + 0 = 38.1$ m

(Continued)
$v_{fy} = v_{iy} + a_y t$
c) $v_{fx} = v_{ix} = 13.0$ m/s

v_{fy} = 7.5 m/s +(-9.8 m/s^2)(2.93 s) = -21.2 m/s

Find final speed and angle

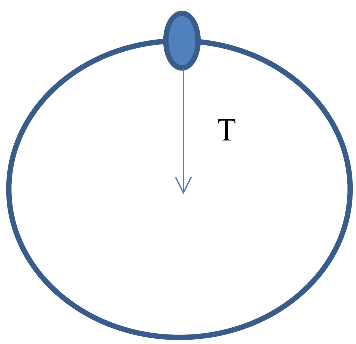
$$|v_f| = \sqrt{(v_{fx})^2 + (v_{fy})^2} \qquad \theta_i = tan^{-1}\frac{v_{fy}}{v_{fx}}$$

$$|v_f| = +/-\sqrt{(13.0\ m/s)^2 + (-21.2\ m/s)^2} = 24.9 \text{ m/s} \qquad \theta_i = tan^{-1}\frac{13\ m/s}{21.2\ m/s} = 31.5$$

Therefore the final velocity is 24.9 m/s @ 31.5^o below the horizontal

21 A 0.100 kg rock is attached to a 2.00 m long string and swung in a horizontal circle at a speed of 30.0 m/s. Find the tension in the string. Neglect the effect of gravity.

Overhead view



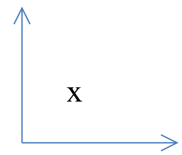
$F_c = ma_c$

$$|T| - 0 = \frac{mv^2}{r}$$

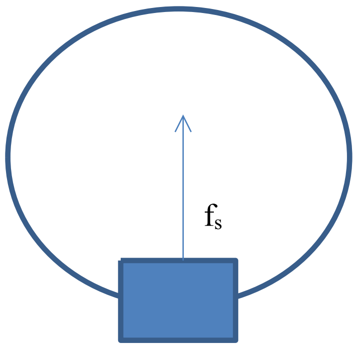
$$|T| - 0 = \frac{(0.1kg)(30\frac{m}{s})^2}{(2\ m)}$$

T = 45 N

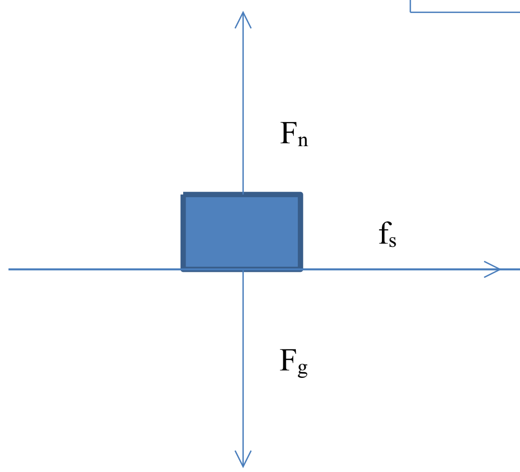
23 A passenger of mass 50.0 kg is in a car rounding a level curve of radius 100.0 m at a speed of 20.0 m/s.
(a) Assuming that static friction is the horizontal force acting on the passenger (between her and the seat), find the magnitude of that frictional force.
(b) What would happen if μ_s is 0.3?



Overhead view



Back View



a)

$F_c = ma_c$

$$|f_s| - 0 = \frac{mv^2}{r}$$

$$|f_s| - 0 = \frac{(50kg)(20\frac{m}{s})^2}{(100\ m)}$$

$F_s = 200$ N

b) We need to calculate $f_{s,max}$. If $f_{s,max}$ is less than 200 N then this car would start skidding and would not be able to complete the circle.

$$F_{net,y} = ma_y$$

$$|F_n| - |F_g| = ma_y \quad (ma_y \rightarrow 0)$$

$$|F_n| = |F_g| = mg = (50\ kg)\left(9.8\frac{N}{kg}\right) = 490\ N$$

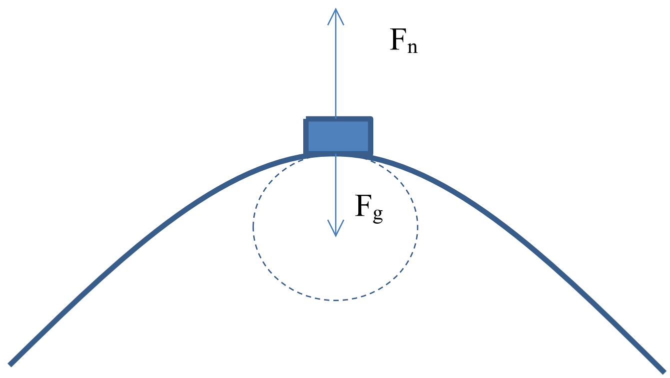
$$f_{s,max} = \mu_s F_N = (0.3)(490\ N) = 147\ N$$

Because a static frictional force of 200 N would be needed for a 50 kg mass to negotiate this turn at 20 m/s and the maximum static frictional force possible is 147 N. This car skids out and follows a straight line path instead.

28 As a 400 kg car rounds the top of a hill at a speed of 20.0 m/s, it very briefly loses contact with the pavement. This section of the road has an approximately circular shape

A) Find the radius *r*.

B) What would be the apparent weight of this person if they were going half as fast?



A) The problem essentially says that that Fn is juuuuuust equal to zero at this moment

$F_c = ma_c$

$$\lim_{\substack{F_n \to 0 \\ v \to v_{max}}} \left(|F_g| - |F_n| = \frac{mv^2}{r} \right)$$

$$|F_g| - 0 = \frac{mv^2}{r}$$

$$mg - 0 = \frac{mv_{max}^2}{r}$$

MASSES CANCEL!

$$r = \frac{v_{max}^2}{g} = \frac{(20\frac{m}{s})^2}{9.8\ m\ /\ s^2} = 40.8\ m$$

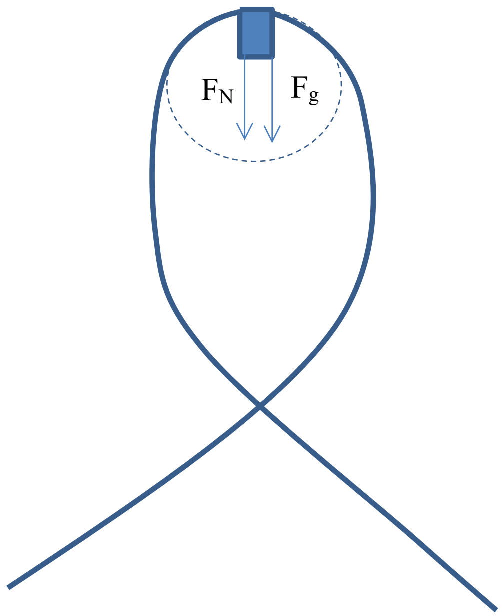
B)

$$F_g - F_n = \frac{mv^2}{r}$$

$$(400\ kg)(9.8\frac{m}{s^2}) - |F_n| = \frac{(400\ kg)(10\frac{m}{s})^2}{40.8\ m}$$

$$|F_n| = \ 2940\ N$$

48 A certain roller coaster design uses a vertical loop of radius 8.00 m.
a) Assuming that the roller coaster remains on the track, what is the minimum speed of a car at the top of the loop?
b) What would be the apparent weight of a 55 kg person at the top of the loop if they are going twice the minimum speed?



$F_c = ma_c$

$$\lim_{\substack{Fn \to 0 \\ v \to vmin}} \left(|F_g| + |F_n| = \frac{mv^2}{r} \right)$$

$$|F_g| - 0 = \frac{mv^2}{r}$$

$$mg - 0 = \frac{mv_{min}^2}{r}$$

MASSES CANCEL!

$$v_{min} = \pm\sqrt{gr} = \sqrt{(9.8\frac{m}{s^2})(8\ m)} = 8.85\ m/s$$

b) $|F_g| + |F_n| = \frac{mv^2}{r}$

$$(55\ kg)\left(9.8\frac{m}{s^2}\right) + |F_n| = \frac{(55\ kg)(2 * 8.85\frac{m}{s})^2}{8\ m}$$

$$|F_n| = 1615\ N$$